

INDIAN CENTRAL JUTE COMMITTEE

ANNUAL REPORT

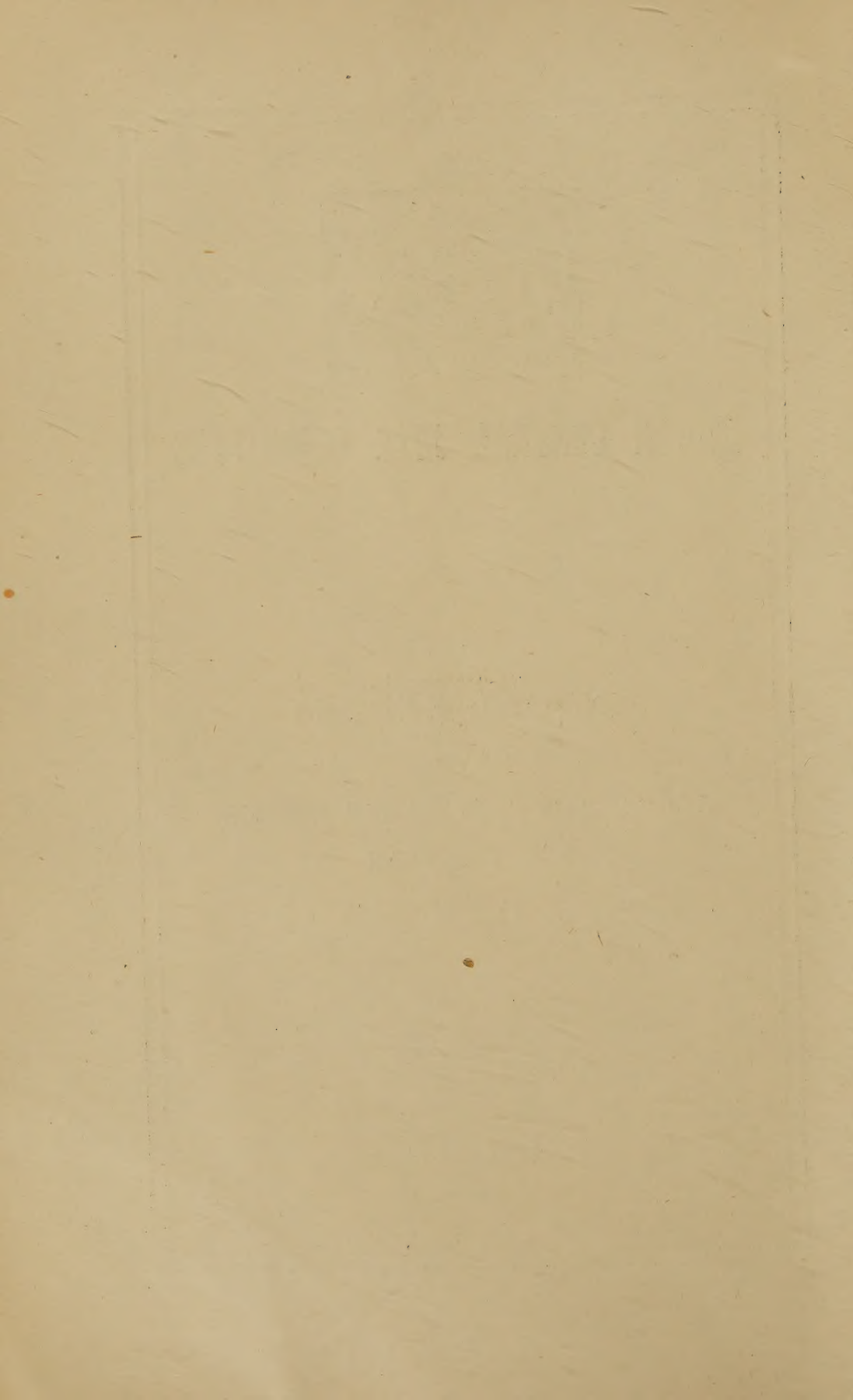
OF THE

AGRICULTURAL RESEARCH SCHEME

FOR THE YEAR

1939-40.

Calcutta:
1940



ANNUAL REPORT OF THE AGRICULTURAL RESEARCH SCHEME FOR THE YEAR 1939-40.

GENERAL.

Arrangements were completed in May 1939 for the supply of water to the laboratories. Electric current and gas were supplied in June. Excepting for a few items of laboratory apparatus, the laboratories were fully equipped for work by the 15th June.

Mr. S. S. Ghosh, who was appointed as the Anatomical Botanist, joined his post on 24th July.

During this first crop season, the members of the staff had an opportunity of studying the jute crop at close-quarters and observing its behaviour and response. In addition to gaining first hand understanding of the crop, they familiarized themselves with the problems in jute and devised appropriate technique for its solution. In spite of this being the first season, very satisfactory progress has been made and I would like to take this opportunity of recording my genuine appreciation of the enthusiasm and the energy with which all the members of my staff carried out their respective duties.

I. COLLECTION OF VARIETIES AND TYPES

With the transfer of the agricultural research work from the Bengal Department of Agriculture to the Indian Central Jute Committee, a collection of 178 "types" was taken over from the Fibre Section. It was grown and studied in detail, particularly with reference to yield, plant height, chlorosis, branching and anthocyanin pigmentation in the plant. It soon became clear that the collection consisted of forty-eight distinct types, as well as single plant cultures. The latter which form the plant-breeding material, have been separated out, and will be further referred to under appropriate heads.

Seeds of two wild species of jute, *C. acutangulus*, and *C. trilocularis*, were obtained towards the end of the year.

Out of the 26 district samples of seed obtained, only twenty two were sown, and their composition was studied. In eight samples, mixtures of *capsularis* and *olitorius* types varying from 0.6 to 6.6 per cent. were observed. Only two varieties proved 100 per cent. pure, others contained green and red plants. The maximum of the foreign type was 44 per cent. and the minimum 6.5. From this it would appear that the "impure" seed is still grown over a considerable area and that the distribution of pure seed should be vigorously pushed forward.

II. SELECTIONS.

A. Cultures received from the fibre section.—

One hundred and eight *capsularis* single-plant cultures were put in a replicated progeny row test. The behaviour of these cultures for anthocyanin pigmentation, chlorosis, and branching habit was recorded. On the basis of important plant characters, and the yield analysis, forty-one selections were deemed worthy of future work. In these cultures the incidence of chlorosis varied from 11 to 100 per cent.

A replicated progeny row test, consisting of fifty *olitorius* selections, had to be abandoned on account of very poor germination. The test will be laid down in the coming season.

Twelve *capsularis* cultures and varieties were tried in a preliminary yield test, but the varietal effects did not prove significant in either yield of fibre, green weight, height or fibre percentage *vide* Table I. Four varieties yielded more than D.154, and of these not more than three may be carried forward. The percentage of fibre varied from 5.2 to 6.3 and the height from 5.9 to 6.4 feet.

A preliminary varietal test was run with six *olitorius* cultures and varieties. Two varieties, G.O. $\times$ Lalpat, and R.26 $\times$ G.O., yielded more than the standard type Chinsurah Green, but the differences were not significant, *vide* Table II. These three varieties were bracketed together in respect of green weight, and height, but the fibre percentage of R.26 $\times$ G.O. was significantly less.

TABLE I.

Capsularis Varietal Test second stage.

Object :—To compare the yields of the strains against the standard D. 154.

Layout :—Randomized blocks in 4 replications. Effective size of plot = 1/215 acre. Sown in South Mirrortek on 10-5-39. Harvested—Megnal Satnal, Barapat and Dhaleswari, on 4-9-39 and the other nine varieties on 18-9-39.

	Stand at harvest per acre.	Green wt., lb. per acre.	Fibre yield, lb. per acre.	Percentage yield on control (D. 154).	Percentage of fibre to green wt.	Mean ht. of plants in ft.
Cross late ...	136466	14445	816	90.1	5.7	5.96
D. 154 × D. 27 ...	132767	15597	895	98.8	5.7	5.90
D. 154 U. F. 2.12 ...	131427	16187	923	101.9	5.7	6.22
Barapat × D. 154 ...	129926	16562	949	104.7	5.7	5.97
Barapat ...	128211	14306	803	88.6	5.6	5.90
D. 154 ...	126925	15544	906	100	5.7	6.05
Megnal Satnal ...	124459	15309	964	106.4	6.3	6.28
Fanduk × D. 154 green ...	123602	14713	891	98.3	6.0	6.36
K. B. sgi. ...	121994	16348	1034	114.1	6.3	6.00
D. 89 ...	117491	16750	873	96.4	5.2	6.44
Deodhali ...	106342	13373	783	86.4	5.8	6.36
Dhaleswari ...	93639	12960	737	81.3	5.7	6.05
P ...	Large	Large	Large	...	Large	Large
S. E. % ...	7.30	6.90	8.66	...	4.05	2.59
Conclusions ...	NOT SIGNIFICANT.					

TABLE II.

Olitorius Varietal Test second stage.

Object:—To compare the yields of the strains against the standard Chinsurah Green.

Layout:—Randomized blocks in 6 replications. Effective size of plot = 1/260 acre. Sown in South Mostertek on 9-5-39. Harvested on 19-9-39.

—	Stand at harvest per acre	Green wt., lb. per acre	Fibre yield lb. per acre	Percent-age yield on control (Chinsurah green)	Percent-age of fibre to green wt.	Mean height of plants in feet
A. G.O. Aksir ...	150638	9612	699	94.1	7.25	5.55
B. R26 × G. O. ...	144979	11902	769	103.5	6.52	6.37
C. G.O. × Lalpat	141869	12118	804	108.2	6.70	6.21
D. Chinsurah Green ...	140270	11232	743	100	6.65	6.03
E. G.O. Jap ...	134482	9850	674	90.7	6.90	5.73
F. Berhampore Local ...	123509	9202	557	75.0	5.93	6.16
P ...	Large	0.05	0.05	...	0.05	0.05
S. E. % ...	5.30	7.22	7.50	...	3.50	2.72
Sig. diff. ...	...	2239.6	155.6	...	0.670	0.475
Conclusions	Not significant	CBDEAF	CBDAEF	...	AECDBF	BCFDEA

B. *Criterion for selection.*—

The results of above trials indicate that either genetic variance is limited in the available material, or that the basis of selection is not as sound as it should be. To arrive at a sound criterion for future selection work, a number of plant characters were evaluated. Height, diameters at the base, middle and top of the stem, thickness of bark at the base, fibre length, and stripped and unstripped green weights of 1,000 plants of D.154 were recorded. Forty five total correlations which were worked out, proved positive and significant *vide* Enclosure I. All the correlations with the fibre percentage were low. Of the diameters measured at three levels, the base diameter was considered most reliable and useful. Of the two green weights of plants, stripped weight (leaves removed) is to be preferred as the green weight of the entire

plant would depend upon the dessication of the leaves. The five useful characters are, fibre weight, weight of the green plant stripped of its leaves, plant height, diameter of the stem at the base and bark thickness. With these five varieties seventy partial correlations were computed *vide* Enclosure II.

The stripped weight of the plant proved to be independently and highly correlated with the fibre yield. When the height of the plant was kept constant, the correlation between the fibre weight and the base-diameter was $+0.813$. When the base diameter was kept constant the correlation between the height and the fibre weight was reduced to $+0.368$. The base-diameter and the height are the most convenient characters to work with in the field, and of these two the former is more reliable. Outstandingly tall plants can be noticed in the field and the diameters of their stems can be readily measured. The greater the thickness and the greater the height of the stem, the larger is the out-turn of fibre.

TABLE III.
Validity of the basis of selection.

Classes of fibre yield in gms.	Frequencies of plante selected on basis of—			
	Plant height above 190 cm.	Base diameter above 16.0 mm.	P. H. above 190 cm. & B. D. above 16.0 mm.	Fibre yield alone.
15.5—16.4	1	1	1	1
14.5—15.4	2	2	2	2
13.5—14.4	3	4	3	4
12.5—13.4	3	4	3	4
11.5—12.4	2	4	2	4
10.5—11.4	6	12	6	13
9.5—10.4	9	13	8	14
8.5—9.4	14	15	4	26
7.5—8.4	20	12	6	35
6.5—7.4	15	5	1	45
5.5—6.4	12	4	...	71
4.5—5.4	7	1	...	80
3.5—4.4	3	...	...	140
Total ...	97	77	36	439
Mean fibre yield ...	8.4	9.8	10.7	6.1

The validity of these two criterion was further tested by making selections from the same population of 1,000 plants. Ninety-seven plants had a height of 190 cm. or over, and their fibre yields ranged between 3.5 and 16.4 grams, *vide* Table III. Seventy-seven plants had a base diameter of 16.0 mm. or over. There were only thirty-three plants which passed the minimum height as well as the diameter, and their fibre outturn ranged between 6.5 and 16.4 grammes. When the plants are selected on the basis of height and diameter of the stem, most of the high yielding plant are included. Thus these two characters offer a useful basis for selecting plants.

It remains to be seen whether these correlations hold equally good in other varieties of jute. If it is found so, then the limits for base-diameter and height could be fixed and only such plants as are above these limits need be selected.

A plant that is selected, has to be kept for seed, and it is not possible to extract its fibre. A sound morphological basis for selection is therefore very necessary in jute.

C. *New selections.*—

As laid down in programme of work, about eight hundred selections have been made.

III. HYBRIDIZATION.

A. *Varietal.*—

By crossing according to the programme, forty-one capsules have been obtained.

B. *Interspecific.*—

Attempts were made to cross *capsularis* and *olitorius* by various methods, such as smear method, application of stigmatic or another paste, mixed pollen, and cut stigmas. Some capsules have been obtained, but it remains to be seen whether the seeds are viable, and if so whether crossing has really taken place.

IV. INHERITANCE OF CHARACTERS.

A. *Chlorosis*.—

In the collection, there were thirty-five non-chlorotic and thirty-three chlorotic parent families. All families whether chlorotic or non-chlorotic, showed chlorosis. The mean chlorosis in non-chlorotic families was 32.8 per cent. and in the chlorotic families 29.9 per cent. the difference being very small. In the absence of pure breeding chlorotic and non-chlorotic families, no crosses were attempted. The study of these families suggests the possibility of chlorosis, not being a genetic character.

B. *Length of fibre*.—

Suitable crosses have been made. But it must be admitted that the variation in height is not large enough, within either *capsularis* or *olitorius* types. Only if the interspecific crosses succeed, differences would be wide enough.

C. *Variant character*.—

The collection contained seventeen variant families. Variants are characterised by deeply serrated small leaves. Of the eleven families that were listed as normal, seven were homozygous and four segregating. The percentages of variants thrown out by the segregating families varied from 11.9 to 18.9 with a mean of 14.5. Of the six variant families two did not germinate at all, two had only one plant each, which were variants, and each of the remaining two families threw out one normal plant. Certain crosses have been made for further study next year.

D. *Colour*.—

All the twenty colour-series-cultures in the collection were classified according to the distribution of pigment in the plant body.

E. *Shape of the pod*.—

In the variety Deodhali the shape of the pod is oval, more or less intermediate between *capsularis* and *olitorius*. A few crosses have been made to study the inheritance of this character.

V. QUALITY OF JUTE.

A. *Effects of varieties, growth conditions and different kind of retting waters on the quality.*—

Three varieties of jute were grown at various stations, in randomized plots with twelve replications. Assistants were sent both for sowing and harvest. It was originally proposed to send half of the green produce of each plot for retting at Dacca, but this was found impracticable as it meant transport of huge quantities of green stuff to Dacca. Approximately ten per cent. of the green produce of each plot, sampled at random, was sent to Dacca for retting. The remaining material was retted at the respective stations.

At each one of these stations, stand, plant-heights, green weights, and fibre weights were recorded. Notes regarding flowering, incidence of pests and disease etc., were kept.

The samples of fibre have been sent to the Director, Technological Laboratories, for technological tests. Till the results of these tests are available no comments can be made regarding the quality of jutes. It may however be mentioned that irrespective of the locality where the plant was grown, the Dacca retted fibre proved darkest in colour. Rootiness was also more pronounced in the Dacca retted fibre.

(a) *Capsularis*.—Varieties D.154, D.386 and Fanduk were grown at Dacca, Rangpur and Faridpur farms. The season at Dacca was rather late, otherwise the conditions may be judged as fair. At Rangpur, the trial was sown on March 28th and harvested rather late between 11th and 24th September. Immediately after sowing there was a draught, which affected the stand. The stand was adjusted by analysis of co-variance. At Faridpur, the attack of semilooper, and later on the cyclonic weather damaged the crop to some extent. In table IV order of merit and significances of differences are furnished for stand, yield of fibre and green weight, height, and percentage of fibre.

TABLE IV.

Capsularis varietal trial for yield and quality.

Object.—(1) To compare the yield of strains.

(2) To study the effect of varieties, growth conditions, different kinds of retting water and duration of retting on quality.

Layout—Randomized blocks in 12 replications.

(a) *Capsularis*.

	Varieties.			P	S.E. %	Sig. diff.	Con-clusion.	REMARKS.
	A D. 154	B D. 386	C Fanduk					
DACCA.								
1. Stand at harvest per acre ...	108415	104866	102938	Large	2.6	...	<u>A B C</u>	Effective plot size 1/50th acre.
2. Green weight in lb per acre ...	18203	17814	18129	„	2.1	...	<u>A B C</u>	Sown in South Mirar Tek on 1-15-39.
3. Fibre yield in lb. per acre ...	1058	1045	930	0.01	1.5	44	<u>AB C</u>	Harvested.—D. 154—16.9-39
4. Percentage yield on control ...	100	98.8	87.9	...	...	...	...	
5. Percentage of fibre to green wt.	5.82	5.89	5.13	0.01	1.3	0.21	<u>BA C</u>	D. 386—15.9-39
6. Mean height per plant in feet ...	6.50	6.58	6.00	0.01	1.04	0.26	<u>BA C</u>	Fanduk—28.8-39
RANGPUR.								
1. Stand at harvest per acre ...	65772	70276	76465	0.01	2.5	5183	<u>C BA</u>	Effective plot size—1/74.
2. Green weight in lb. per acre ...	29369	24328	27666	0.01	3.0	2403	<u>AC B</u>	Sown on 28.3-39.
3. Fiber yield in lb. per acre ...	1963	1954	1692	0.01	2.7	149	<u>AB C</u>	Harvesting.—
4. Percentage yield on control ...	100	99.5	86.2	...	...	...	...	D.154—17.9-39
5. Percentage of fibre to green wt.	6.66	8.16	6.17	0.01	1.4	0.28	<u>B A C</u>	D.386—24.9-39
6. Mean height per plant in feet ...	10.68	10.87	9.77	0.01	1.2	0.38	<u>BA C</u>	Fanduk—10.9-39 & 11.9-39
FARIDPUR.								
1. Stand at harvest per acre ...	146767	145886	148323	Large	1.8	...	<u>C A B</u>	Effective plot size—1/89
2. Green weight in lb. per acre ...	20035	23853	19149	0.01	2.7	1645	<u>B AC</u>	Sown on 9.5-39.
3. Fibre yield in lb. per acre ...	1300	1324	1046	0.01	2.3	83	<u>BA C</u>	Harvest.—
4. Percentage yield on control ...	100	101.8	80.5	...	...	...	...	D.154—15.9-39
5. Percentage of fibre to green wt.	6.45	5.55	5.46	0.01	1.3	0.21	<u>A BC</u>	D.386—21.9-39
6. Mean height per plant in feet ...	6.80	6.94	6.39	0.01	1.4	0.32	<u>BA C</u>	Fanduk—5.9-39 & 6.9-39

TABLE V

(b) *Olitorius varietal trial*

(Layout—Randomized blocks in 12 replications)

	Varieties			P	S. E. %	Sig. diff.	Conclusion	REMARKS
	A* C. G.	B R. 26	C Local					
DACCA								
1. Stand at harvest per acre ...	114,060	114,610	118,975	Large	4.1	...	<u>C B A</u>	Effective plot size = 1/50th acre. Sown in S. Mirar Tek on 9-5-39 & 10-5-39. Harvest.— C. G.—14-9-39 R. 26 18-9-39 Local 13-9-39 & 14-9-39.
2. Green weight in lb. per acre ...	18,578	19,645	18,394	,,	2.3	...	<u>B A C</u>	
3. Fibre yield in lb. per acre ...	1,123	1,035	1,111	,,	2.6	...	<u>A C B</u>	
4. Percentage yield on control ...	100	92.2	98.1	...	...	...	...	
5. Percentage of fibre to green wt.	6.0	5.3	6.1	0.01	1.6	0.40	<u>CA B</u>	
6. Mean height per plant in feet ...	7.67	7.95	7.66	0.01	0.9	0.27	<u>B AC</u>	
CHINSURAH								
1. Stand at harvest per acre ...	86,403	84,095	85,525	Large	3.1	...	<u>A C B</u>	Effective plot size = 1/62 acre. Sown on 16-5-39. Harvest.— C. G.—11-9-39 R. 26 16-9-39 Local 13-9-39
2. Green weight in lb. per acre ...	23,735	25,345	26,079	0.05	2.3	1,681	<u>C BA</u>	
3. Fibre yield in lb. per acre ...	1,466	1,348	1,382	0.01	1.6	65	<u>A CB</u>	
4. Percentage yield on control ...	100	92.0	94.3	...	...	...	...	
5. Percentage of fibre to green wt.	6.16	5.29	5.32	0.01	1.4	0.23	<u>A CB</u>	
6. Mean height per plant in feet ...	9.412	9.679	9.839	0.05	0.9	0.265	<u>CB A</u>	
RAJSHAHI								
1. Stand at harvest per acre ...	147,186	149,745	158,940	Large	2.5	...	<u>C B A</u>	Effective plot size = 1/62 acre. Sown on 27-5-39 Resown on 14-6-39 & 15-6-39 Harvest.— C. G.—22-9-39 R. 26 3-10-39 Local 19-9-39 & 20-9-39.
2. Green weight in lb. per acre ...	7,111	6,811	7,226	,,	4.4	...	<u>C A B</u>	
3. Fibre yield in lb. per acre ...	314	317	297	,,	5.4	...	<u>B A C</u>	
4. Percentage yield on control ..	100	101.0	94.8	...	...	...	...	
5. Percentage of fibre to green wt.	5.64	5.71	5.34	0.05	1.5	0.25	<u>B A C</u>	
6. Mean height per plant in feet ...	3.58	3.78	3.83	Large	2.6	...	<u>C B A</u>	

*Chinsurah Green

The following conclusions may be drawn from the table IV—

- (1) The variety Fanduk, which is respected in trade on account of its quality, yields significantly less than the strains evolved by the Department of Agriculture, Bengal. This low yield of Fanduk is due to low percentage of fibre and early maturity *i.e.* shorter growth period which limits the height and the outturn of fibre of the plants.
- (2) In point of yield of fibre and the height of plant there is no difference between D.154 and D.386.
- (3) Fibre-content appears to be a characteristic of the variety, but its expression is considerably influenced by edaphic factors.
- (4) The height of the plant and its fibre content largely influence the outturn of fibre.

(b) Olitorius.—Varieties, Chinsurah Green, R.26, and the respective locals were grown at Dacca, Chinsurah, and Rajshahi farms. At Chinsurah the crop was water-logged between 25th July to 1st August 1939. At Rajshahi the trial was resown on 14th and 15th June and harvested between 19th September and 3rd October. On account of poor drainage of the land and the heavy rainfall, the plants were so stunted that the trial at Rajshahi must be considered a failure. From the analyses presented in table V, the following conclusions may be drawn.

(1) It is not likely that either at Dacca or at Chinsurah R.26 will supersede Chinsurah Green. R.26 appears to be defective in fibre-content, and superior in height which explains the higher outturn of green matter in R.26 as compared with Chinsurah Green. The important components of yield of fibre appear to be the height of plant and its fibre content.

B. *Study of Retting methods.*—

(a) Survey of the conditions and the prevalent retting methods in Bengal could not be undertaken, as experience and training had to be gained during the first season at Dacca. This will be taken up next year.

(6) *Analyses of retting waters.*—Eighty-six samples of retting waters were chemically analysed for pH, Fe, Ca, Mg, K, Total Solids, Total Permanent and Temporary Hardness, and titrable acidity and alkalinity. The figures for total solids are tentative and should not be taken as final because the estimation was made after sedimentation had occurred. The results of these analyses are given in Enclosure III. The analyses were necessarily confined to the waters in which the experimental jute produced at Dacca, Rangpur, Faridpur, Chinsurah and Rajshahi farms was retted. Samples were examined periodically. From the results it appears that it might be sufficient if the future analyses dealt with only Total and Temporary Hardness, Methyl red Alkalinity and Iron content. Till the results of spinning tests on fibre samples are available, no attempt can be made to link up the quality of the fibre with the chemical composition of the water.

(1) *Standardization of technique.*—The retting-tank at Dacca was divided into nine equal rectangles. The three middle rectangles were left out, as jute is not generally steeped in the centre, the remaining six rectangles on the two broad sides were taken as units. From the centre of each of these six units, samples of water were drawn at one foot and two feet depths. Analyses of these samples revealed that the composition of the water in all the six units was similar. As these samples were drawn before the steeping of jute, the experiment was repeated on a smaller scale after the jute was steeped. Three samples of water from each at one and two feet depths, were drawn from the interspaces between four “jaks” of steeped jute. From these six samples, a one foot depth composite sample, a two feet depth composite sample, and a one foot and two feet depth composite sample, were made up. The results of the analyses of these nine samples showed that a one foot depth composite sample would serve our purpose. This method of sampling was prescribed for all the stations.

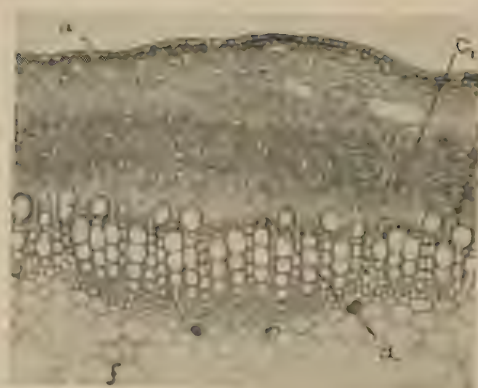
The above analyses of twenty-one samples gave to the Chemical Assistant some practice in this type of work.

(2) *Effect of inflow of outside water on the composition of tank water.*—The Dacca tank has an inlet and an outlet, and the inlet is fed by the farm drain. On 30th of June, before the entry of

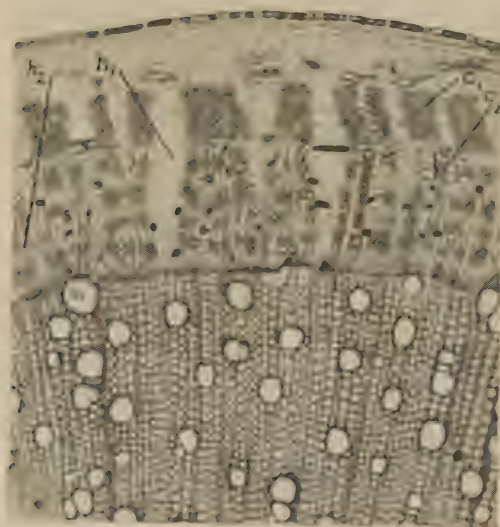
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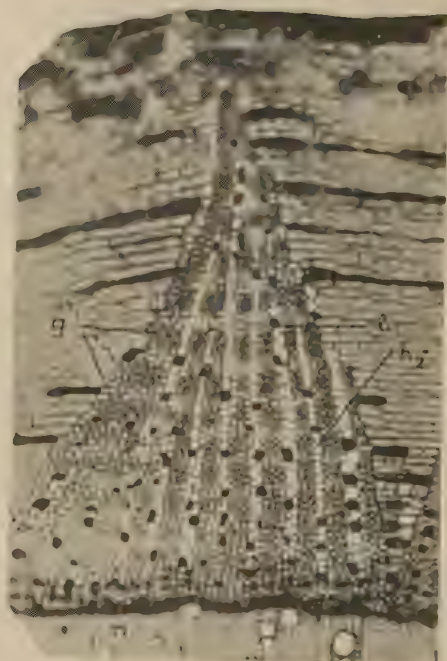
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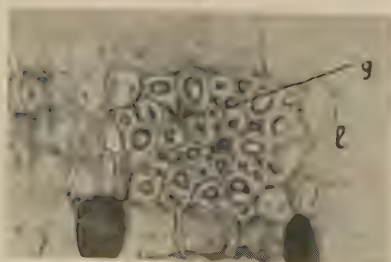
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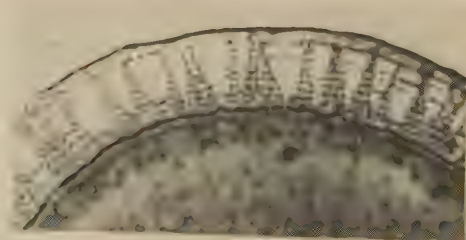
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EXPLANATION OF PHOTOMICROGRAPHS

(All are transverse sections)

PLATE I

Fig. 1.—Section of one inch plant showing the formation of first layer of fibres. Note the concentric arrangement; *a*, epidermis; *b*, cortex; *c*₁ first fibre layer; *d*, cambium; *e*, xylem; *f*, pith; *s*, starch sheath. (×70).

Fig. 2.—Part of a section from the top portion of a mature stem of D.154, showing the formation of first fibre layer. (×60).

Fig. 3.—Part of a section from the middle stem at harvest stage showing the gradual development of fibre layers (*c*₁, *c*₂). Note the radial arrangement of fibres alternating with thin-walled cell layers. First formed fibres (*c*₁), are thicker than the rest; *h*₁, *h*₂ old and new rays; *m*, conducting vessels. (×60).

Fig. 4.—Part of a section at the base of stem at harvest stage showing one complete phloem pyramid containing about 18 layers of fibre. Note dark deposits in the cells of the rays and cortex; *g*, fibre bundle; *n*, wood; *l*, soft tissues. (×60).

Figs. 2, 3 and 4 are comparable as they represent harvest stage.

Fig. 5.—One fibre bundle magnified. Note the shape and thickness of individual fibres. The bundle is surrounded on all sides by soft tissues, *l*. (×500).

Fig. 6.—Part of a section of stem showing the distribution of phloem tongues. (×10).

NOTE: All photo-micrographs are slightly reduced in printing.

water from the drain, one and two feet depth samples were drawn. On 24th August, after the flooding of the tank, twelve samples were taken for standardising the sampling technique. A marked reduction in the titrable acidity was observed after flooding of the tank.

(3) *Changes in the water after steeping.*—After the steeping of jute titrable acidity of Dacca water rose. In the Faridpur water, titrable acidity rose, the potash and total solids increased, and magnesium, iron and calcium were not influenced. Rangpur water was erratic in Ca and K, but Fe, Mg, and titrable acidity did not change appreciably. This might be due to the gentle flow in the "bheel" water at Rangpur. There was some rise in the titrable acidity, and total solids at Chinsurah, and lime content was somewhat erratic. At Rajshahi there was an indication of the increase in acidity, the calcium and potash contents were rather erratic.

On the whole, it appears that during the retting, a rise occurs in the titrable acidity and some of the potash from the jute plant diffuse out into the water. Steeping does not appear to influence either iron or magnesia. The erratic behaviour of calcium content could not be correlated. Open tanks and flowing waters are not quite satisfactory for the study of changes in the waters during retting.

(4) *Nature of the waters.*—From the analyses it is evident that waters of different stations vary greatly in their constituents, the Dacca water being the softest and Faridpur being the hardest. The iron content is rather low in all the waters.

C. *Formation of Bark or 'roots'.*—

Rooty fibre constitutes about 10—30 per cent. of the output and this is attributed to the rooty or barky nature of the plant. In order to study the causes which aid the development of the 'rooty' fibre, three plots were selected and embankments were raised to hold sufficient water necessary for the experiment. In each plot two varieties *viz.*, D.154 and Fanduk, were sown. After the plants were two months old, the plots were flooded artificially. Plot No. 1 was alternately kept flooded and dry. The depth of water when flooded was maintained at 18 inches. The remaining two plots were flooded continuously for 45 days,

with the level of water standing at eighteen and nine inches in plots 2 and 3 respectively. After this operation, the plants were harvested and the extent of root development on the stems was measured in every fifth plant. The results are summarised in table VI.

TABLE VI

Plot	Treatments.	Length of stem in inches on which roots developed.			
		D. 154		Fanduk	
		Av.	Range	Av.	Range
1	Flooded 15 days, dry 15 days and flooded 15 days in 18" of water. ...	5.8	3.5—8.5	4.3	0 —8.0
2	Flooded for 45 days in 18" of water ...	4.2	2.0—6.0	3.4	1.5—7.0
3	Flooded for 45 days in 9" of water ...	2.5	1.0—8.0	1.7	0 —6.0

When the plants were subjected to alternate flooding and drying, they produced more and longer roots. The growth of adventitious roots on an average was more in D.154 than in Fanduk. In the plants grown in 9" depth of water, the root zone was shorter and it terminated abruptly.

Transverse sections of very rooty stems of D.154 and Fanduk were cut and examined. It has been observed that these roots are always confined between the phloem tongues *i.e.*, in the area occupied by the older rays. In a very early stage the structure of this root resembled that of an ordinary root, but the former developed from the parenchymatous cells of the rays opposite the cambium. At first the root-tip lies near the cambium but as the development proceeds it pushes outside making its way through the entire region of the ray and the cortex, finally coming out of the stem as a free root. Later on considerable tracheal tissue develops and it may even penetrate into the xylem or wood. This growth may be such as to fill up a considerable portion of the funnel shaped ray and establish sideways connection with the phloem tongues where the fibre groups are situated. The

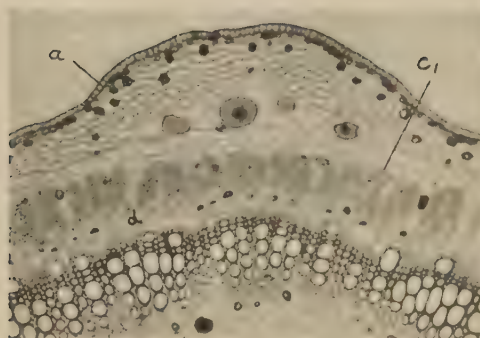
original ray parenchyma and cortical cells of this area, become disorganized, lose their characteristics, and assume a clumsy shape due to the development of hard tracheal tissue in the root. In several cases, root growth was noticed a little below the outer surface or upto the middle of the cortical region and far away from the cambial zone. Only in advanced stages the roots come in contact with the phloem tongue and such cases may offer difficulty in the process of retting and extraction of the fibre. The hard tracheal tissues may not get dissolved as quickly as the soft tissues of the cortex and rays and, therefore, some fibre bundles may remain sticking to these roots.

The stems of Chinsurah Green having no external evidence of adventitious roots, when cut and examined under the microscope, showed the development of roots as in D.154. This indicates that certain cells of ray parenchyma retain their potentiality to be meristematic, but may not differentiate fully until the environmental conditions are favourable.

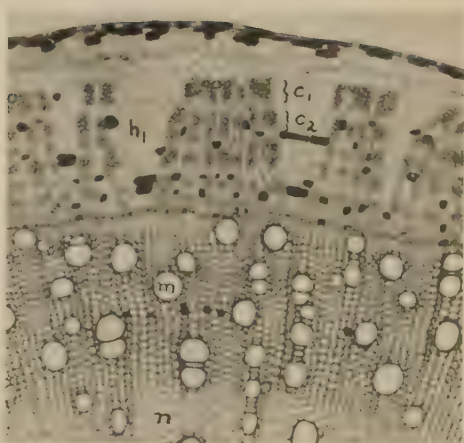
Generally in plants the adventitious roots develop near about the nodal region of the stem, but in jute they are conspicuous all over the internodes.

The outer superficial layers of the stem which sometimes flake off as dead tissue are the periderm. When a large quantity of periderm adheres to the fibre, this fibre is called baky in commercial circles. Periderm, or what is popularly mis-termed 'bark', forms below the epidermis. It consists of the layers *viz.*, phellem, phellogen and phelloderm in respective order. Phellogen is the secondary meristem that gives rise to phellem and phelloderm, the former being on the outside and latter on the inner side. The entire periderm in jute is a very thin layer, composed of generally 1—4 rows of rectangular and radially flattened cells. The phelloderm is not very distinct and may consist of only one layer. The phellem is the main layer and in the lower portion of the stem it is suberized to some extent. After the formation of periderm, the epidermis often gets ruptured. In D.154 the rupture of the epidermis is found to occur up to the middle of the stem irrespective of the fact whether it is grown on high or low land. Particularly in plants grown in water, the cortical parenchymatous cells, just below the periderm, become irregularly arranged, forming a loose tissue with air spaces. This structure often has

Plate II



1



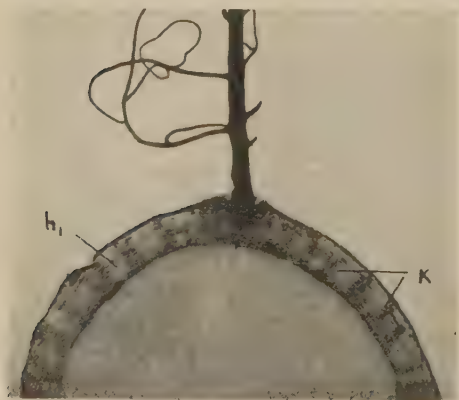
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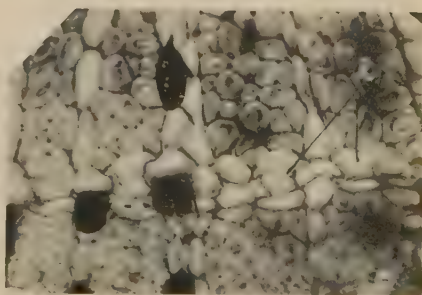
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6

EXPLANATION OF PHOTOMICROGRAPHS

(All are transverse sections)

PLATE II

Fig. 1.—Part of a section from the top portion of a mature stem of Chinsurah green showing the first formed fibres (c_1). ($\times 60$).

Fig. 2.—Part of a section from the middle of the mature stem. ($\times 60$).

Fig. 3.—Part of a section from the base of a mature stem showing phloem pyramid containing 12 layers of fibre. Note its compact nature. ($\times 60$). Figs. 1, 2 and 3 are comparable as they represent harvest stage.

Fig. 4.—Adventitious root, (j) developing within the stem and is situated in between two phloem pyramids; i , periderm. ($\times 50$).

Fig. 5.—Part of a section through the adventitious root region of the stem. Note the position of the root in relation with the fibres and phloem pyramids (k). ($\times 6$).

Fig. 6.—Fibre bundles in Chinsurah green magnified. Note soft tissues (l) consisting of sieve tubes, phloem parenchyma etc., ($\times 500$).

Note :—All photo-micrographs are reduced slightly in printing.

the resemblance of the aquatic plants. Possibly this loose cortical tissue collapses soon after steeping, thereby allowing the suberized periderm layer to come in contact with the fibre bundles. The periderm gets stuck to the fibre layers on account of gummy or other deposits and it is possible that weight of the steeped jute aids this process.

In Chinsurah green, the periderm is not very distinct, but may develop late in the life history of the plant. The cuticle is thick and certain amount of periderm can be located sometimes near the lenticels, where the activity is seen with the best advantage as these are closely associated with the initial periderm sheath.

The distribution of lenticels is more or less of diffuse type. In D.154 they are prominent in the adventitious root region, and whether there exists any relation between the two is worth investigating.

Development of roots during storage in Dowrah and Tippera jutes could not be studied as the samples were not received.

D. *Formation of the fibre.*—

For the purpose of this study the plants of D.154 and Chinsurah green were grown in two special plots. Each plot was divided into ten sub-plots and from each one of these sub-plots a plant was selected at random. The stems were fixed in formalin-acetic-alcohol. Specimens were fixed on every fourth day, but late in the season an interval of seven days was adopted.

Free hand sections were cut from young plants, and hard and thick stems were sectioned with a sledge microtome. Growing tips and delicate stems were embedded in paraffin for serial sections. Mayer's fixative was used for fixing sections on the microscope slides. A number of stains have been tried. Haidenhain's iron haematoxylin and safranin may be an ideal stain but it is a very long process. Safranin and aniline blue is quicker and as a single stain Rosanilin gave the quickest results. Fast green F C F which was received very late in the year, gave very good results when used against safranin. For permanent mounts xylol-balsam has only been used.

The material collected is very large and it will take considerable time to section all the material necessary for detailed studies.

In a young internode of growing shoot the structure is simple and composed of epidermis, cortex, primary vascular bundles and the pith. The outline of the section is not yet round on account of the presence of short ridges and grooves. The epidermis is distinct and composed of mainly one layer of cell though occasionally a sub-epidermal layer may be observed. Short hairs are present and glandular hairs are prominent near the apex. In the cortex, intercellular spaces and the secretory canals are present. Collenchyma and parenchyma can be distinguished. Just below the cortex, there is starch sheath which encloses the vascular cylinder. This sheath is distinctly visible when stained with iodine-potassium-iodide, because the starch grains within the cells are coloured deep blue to black. Pericycle situated below the starch sheath is difficult to distinguish. Starch sheath and pericycle which are the features of an early stem, soon get ruptured on account of the secondary growth. The primary vascular bundles are collateral and the stele is of ectophloic siphonostele type and in an early stage may look like a dissected one. The bundles which are first isolated, with further growth form a complete cylinder. The primary phloem is not as conspicuous as the primary xylem. Later on with the activity of cambium the primary phloem loses much of its characteristics. The pith consists of large, loosely arranged, parenchymatous cells. Secretory canals are a prominent feature of this tissue, and they appear even in the region of the growing tip. Generally they are five in number but more than that have often been observed.

Like many other plants, in jute also, there exist two types of fibres. That lying outside the cambium, that is, in the region of the bark is called phloem or bast fibre. The one lying on the innerside of the cambium is called xylem or wood fibre. The jute fibre of commerce is the product of the former type.

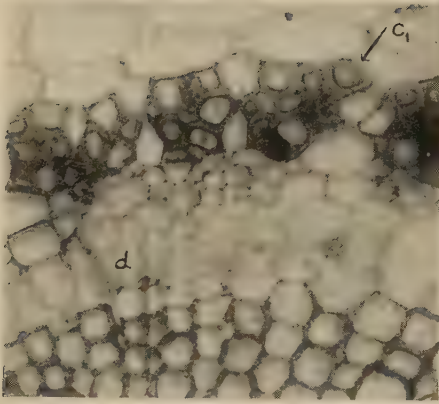
As soon as the cambium becomes active and extends all round the stem in a concentric manner, it goes on generating cells on both sides of it. In the meantime another great change takes place just below the starch sheath adjoining the inner cortex. Cells in the region of the primary phloem, which were formerly thin walled and small, enlarge, lose their contents, and assume definite shape and arrangement. When sufficient cell-wall thickening has taken place they are recognized as fibres. The arrangement of these first formed fibres in a cross-section is

concentric, but not exactly continuous due to the presence of large parenchyma cells of the rays which on further development separate the fibres more and more. The first formed fibres appear to have somewhat thicker walls than those of the later formed fibres.

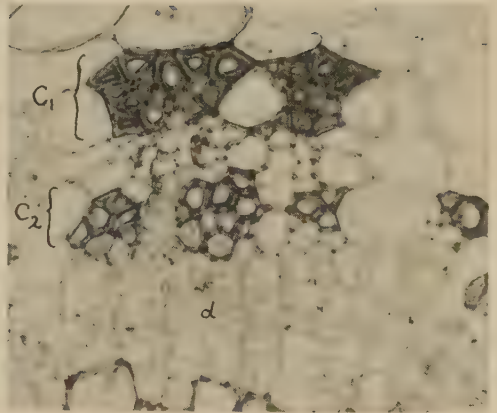
The first fibre layer appears very early in the life of the plant and therefore the period of actual pre-fibre formation stage is very short. Its appearance synchronizes with the development of the fourth leaf. With the growth of the plant more and more new layers are cut off by the cambium towards the region of the bark and below the first formed fibre layer. New fibres are formed in layers or sheets which alternate with the thin-walled cell layers. When the plant has attained considerable height, the phloem which constitute by now a substantial part of the bark, become very striking and the cut end of the stem now takes a star shaped appearance. The distribution of the phloem in the bark is just like an array of so many pyramids or trapeziums on the woody cylinder of the stem. The wedge between the phloem pyramids consists of older rays. In D.154, it has been noticed that these phloem pyramids tend to split more with the result that they very often look like so many tongues protruding towards the outer surface of the stem. Within a short span of four months about eighteen layers of fibres are produced in D.154, and about thirteen in Chinsurah green. The number of fibre layers diminishes from the bottom to the top as the plant tapers upwards, and near the apex there may be only one layer of fibre. Since a majority of the fibre layers are formed between the ages of $1\frac{1}{2}$ to 3 months, this period should be the most critical for jute. It may be noted that fibres formed towards the exterior are older and those towards the interior are younger. With the advent of the reproductive phase in the plant, the cambium which was so long actively engaged in giving rise to fibres and other cell structures begins to show signs of inactivity, and starts shrinking with the result that hardly any new fibre layer is laid afterwards. The harvesting of jute should synchronise with this phenomenon.

The fibres themselves are not isolated but a group of them varying in number are coherently attached against each other. The bundles or groups of fibres are surrounded on all sides by thin-walled soft tissues. Strips of ray parenchyma are on the

Plate III



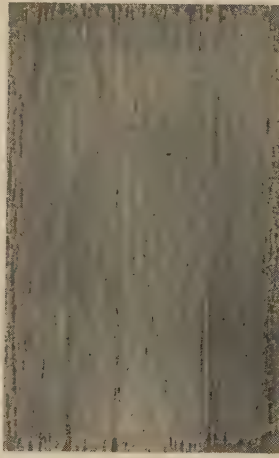
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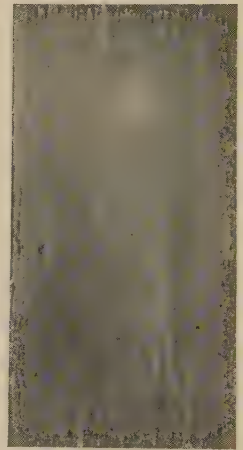
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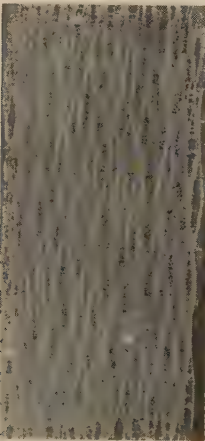
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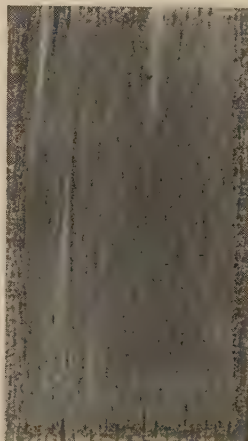
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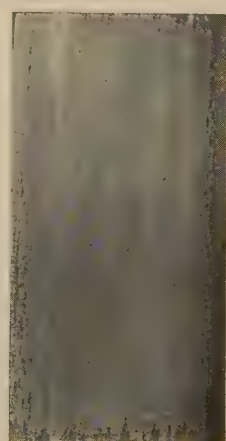
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8

EXPLANATION OF PHOTOMICROGRAPHS

PLATE III

Fig. 1.—Transverse section of a stem showing, first formed fibres (c_1) highly magnified. Note wide cell opening indicating that the cell wall thickening is not yet complete. ($\times 600$).

Fig. 2.—Transverse section of stem. Development of first formed fibres (l) is complete and the second layer (c_2) is progressing. Note the cambium (d) just below wherefrom the fibres originate. ($\times 600$).

Figs. 3—5.—Fibre arrangement in D.154 as it occurs in the plant. Fig. 3 from the bottom portion, Fig. 4, from the middle and Fig. 5, from the top of the same plant. Note the length and breadth of the fibre net work at three regions. ($\times 3$).

Figs. 6—8.—Fibre arrangement in Chinsurah green at the corresponding three different regions. ($\times 3$).

NOTE: All photo-micrographs are slightly reduced in printing.

radial sides of the bundle and on the tangential sides, sieve tubes, companion cells, and parenchyma of the phloem are met with. These thin-walled cells when retted get dissolved and fibres are freed. These parenchyma cells often contain deposits which are stained black in iron-alum-haematoxylin. The deposits are more prevalent in the older portions of the stem than in the young parts. The groups of fibres may be rectangular, squarish, radially elongated or even may be irregular in outline or shape. The number of individual fibres contained in each group may be only a few or many. The number of fibre bundles is greater near the cambium than towards the periphery. The individual fibres when cut across are generally many sided and thick-walled. Schulze's solution imparts to it yellow colour, acidulated phloroglucin light red, and anilin sulphate light yellow, indicating the lignified nature of the fibres. The lumen may be wide to almost closed, depending upon the progress of cell wall thickening. An attempt has been made to compare in D.154 and Chinsurah green at harvest stage, the approximate fibre area, number of fibre bundles per section, and the total number of fibres in each bundle. One hundred readings of bundles were taken from each plant and stems of five plants were thus examined. The sections were cut from stems 8 inches above the ground level. It was observed that (a) Chinsurah green has significantly more of fibre cells per bundle than D.154, (b) the area of each fibre bundle is significantly more in Chinsurah green than in D.154, (c) the number of fibre bundles per cross-section is significantly greater in D.154 than in Chinsurah green and on this account the volume of fibre is greater in D.154 than in the *olitorius* type. The observations have been summarised in Table VII.

In vertical tangential sections, the arrangement of fibres in the plant as they are, is very striking. Fibres or rather group of fibres run along the stem in a somewhat sinuous course, binding thin areas which may be bi-convex or spindle shaped or vertically elongated with tapering ends. The individual ray cells are often radially flattened and tangentially stretched. The fibre groups form a mesh or net work in relation with the rays. As one progresses from the outside towards the cambial zone, the fibre mesh gradually becomes narrower and shorter as the fibres are now separated by only young rays which are smaller than the old rays. Near the base of the stem the mesh is long and wide,

TABLE VII

CHARACTER	CHINSURAH GREEN	D. 154
Pith	Collapsed.	Persisting.
Xylem	Less developed in extent but cells are thickwalled and more lignified. For this reason the stem of C. G. is harder than D. 154. From the structure of cells, it is evident that diameter growth is slow and uniform with sudden flushes at times.	More developed in extent, cells are larger, thin walled, less lignified and sometimes irregular in arrangement. Stem softer. The diameter growth is uniformly fast with occasional slackening.
Phloem tongue	Composition same, with alternate layers of fibres and sieve tubes, companion cells, parenchyma but the entire structure is more compact. The rays and phloem cells are not very wide and sometimes less in number.	Less compact due to more development of soft tissues in size and distribution. The rays and phloem cells are bigger and sometimes more in number.
Fibre bundle	2181 per cross section.	2573 per cross section.
Area of fibre bundle	2766 sq. microns.	2573 sq. microns
Number of fibres in each bundle	Average 15.8.	Average 14.5
Crystals	Not common.	Large and frequently present, particularly near the phloem tips.
Periderm	Indistinct, and appears late.	Distinct, as shown by several rows of radially flattened cells, often suberised. Appears very early.
Epidermis	Persists for long.	Often breaks away with age and with the development of periderm.
Xylem vessels	More than D. 154 in distribution.	Less than C. G. in distribution.

and it gradually diminishes in size as the top is approached where the mesh is not apparently visible. The fibres obtained from the bottom and outer part of the stem are likely to be coarse textured.

The length or the depth of the mesh in five varieties of jute was studied at three different levels. The figures tabulated below show that the length of the mesh varies with the variety and that it gradually diminishes from bottom towards the top, but the rate is not proportional.

TABLE VIII.
Length of the mesh—Average of 30 readings.

Height of the stem above ground level	D-154	Fanduk	D. 386	R. 26	Chinsurah green
$\frac{1}{4}$	*205.50	193.83	185.66	156.66	149.66
$\frac{1}{2}$	146.33	146.00	155.66	141.33	148.66
$\frac{3}{4}$	101.50	93.66	104.00	100.50	107.66

*1=19 Microns.

The following table shows that both the length and the width of the mesh decrease as one progresses from the base to the top of the plant. The size of the mesh appears to be a varietal character, but within a plant it depends upon the thickness of the stem.

TABLE IX.
Relation between the diameter of the stem and the size of the mesh.

Chinsurah green			D. 154		
Diameter of stem, mm	Mean mesh length	Mean mesh width	Diameter of stem mm	Mean mesh length	Mean mesh width
9.0	*186.3	*14.8	12	*222.8	*27.3
7.8	146.5	11.8	10	182.3	16.6
7.5	126.2	10.2	8.5	158.8	12.4
6.0	104.5	8.0	7.0	124.5	8.5
5.5	96.0	6.7	6.0	103.2	5.9
4.5	70.5	5.9	5.0	69.3	4.5
3.5	62.5	3.3	4.5	57.8	2.6

1=19 Microns.

VI. CULTIVATION.

This phase of the work deals with the methods of raising a jute crop. The aim is to introduce cultural methods that are superior and more economical.

A. *Line sowing*.—

If jute can be sown in lines, the cost of weeding could be reduced, and improved drainage consequent on the formation of ridges might benefit the crop.

In the broadcast sown plots, the stand was much thicker and the out-turn of fibre higher. The plants were taller in the line-sown plots with close spacing ($12'' \times 2''$). If the comparisons are made on the basis of calculated yields per 100 plants, a spacing of $24'' \times 2''$ appears to be the best. In the absence of replications it is difficult to arrive at any conclusions regarding the yield, but it is clear that line-sowing is worth further investigation.

B. *Spacing and manurial experiments on seed jute*.—

With a view to cheapen the cost of production of seed in Bihar, a combined spacing and manurial experiment was laid down at Pusa and Sabour farms. Rows were sown 15, 24 and 30 inches apart and the spacings between the plants (within a row) were 6'', 12'' and 18''. The manurial treatments were (A) no manure, (B) 125 lb. of Niciphos II per acre (20 lb. N + 20 lb. P_2O_5) and (C) 250 lb. of Niciphos II per acre. The variety D.154 was sown at Pusa on 22nd July and harvested on 23rd November. Chinsurah green was sown at Sabour on 30th June and 1st July and harvested between 28th October and 26th November as the pods ripened. From the summary of results given in Table X, it is clear that line sowings proved as efficient as the broadcast. At both the places $6'' \times 15''$ spacing yielded more than the broadcast, but the differences were not significant. Plots having rows 30 inches apart yielded significantly less, irrespective of the spacing between the plants. In general the spacing of 18'' between the plants appears to be defective. The application of 125 lb. of Niciphos II per acre proved to be the most economical manure. The effects of fertilizer application were significant but the difference between the double dose and the single dose was not significant.

TABLE X.

Summary of results of seed jute experiments.

PUSA			SABOUR		
Spacing		Total yield (gm)	Spacing		Total yield (gm)
6" × 15"	...	16854.5	6" × 15"	...	25720
Broadcast	...	15097.1	6" × 24"	...	25108
18" × 15"	...	14585.4	12" × 15"	...	24384
12" × 24"	...	14131.4	12" × 24"	...	20588
6" × 24"	...	13679.5	Broadcast	...	20453
12" × 15"	...	13393.9	12" × 30"	...	19256
6" × 30"	...	12711.6	18" × 24"	...	18612
18" × 24"	...	9874.2	18" × 15"	...	17577
12" × 30"	...	8059.1	6" × 30"	...	17290
18" × 30"	...	7547.4	18" × 30"	...	14250
Sig. diff.	=	3669.0	Sig. diff.	=	6975

Manures		Total yield (gm)	Manures		Total yield (gm)
C=250 lb.			C=250 lb.		
Niciphos II			Niciphos II		
per acre	...	46251.1	per acre	...	73768
B=125 lb.			B=125 lb.		
Niciphos II			Niciphos II		
per acre	...	44551.8	per acre	...	70492
A=No manure		35131.2	A=No manure		58978
Sig. diff.	=	3961.2	Sig. diff.	=	9799

Manure × spacing interaction	Manure × spacing interaction
Significant at 5 per cent.	Not significant.

VII. DISEASES.

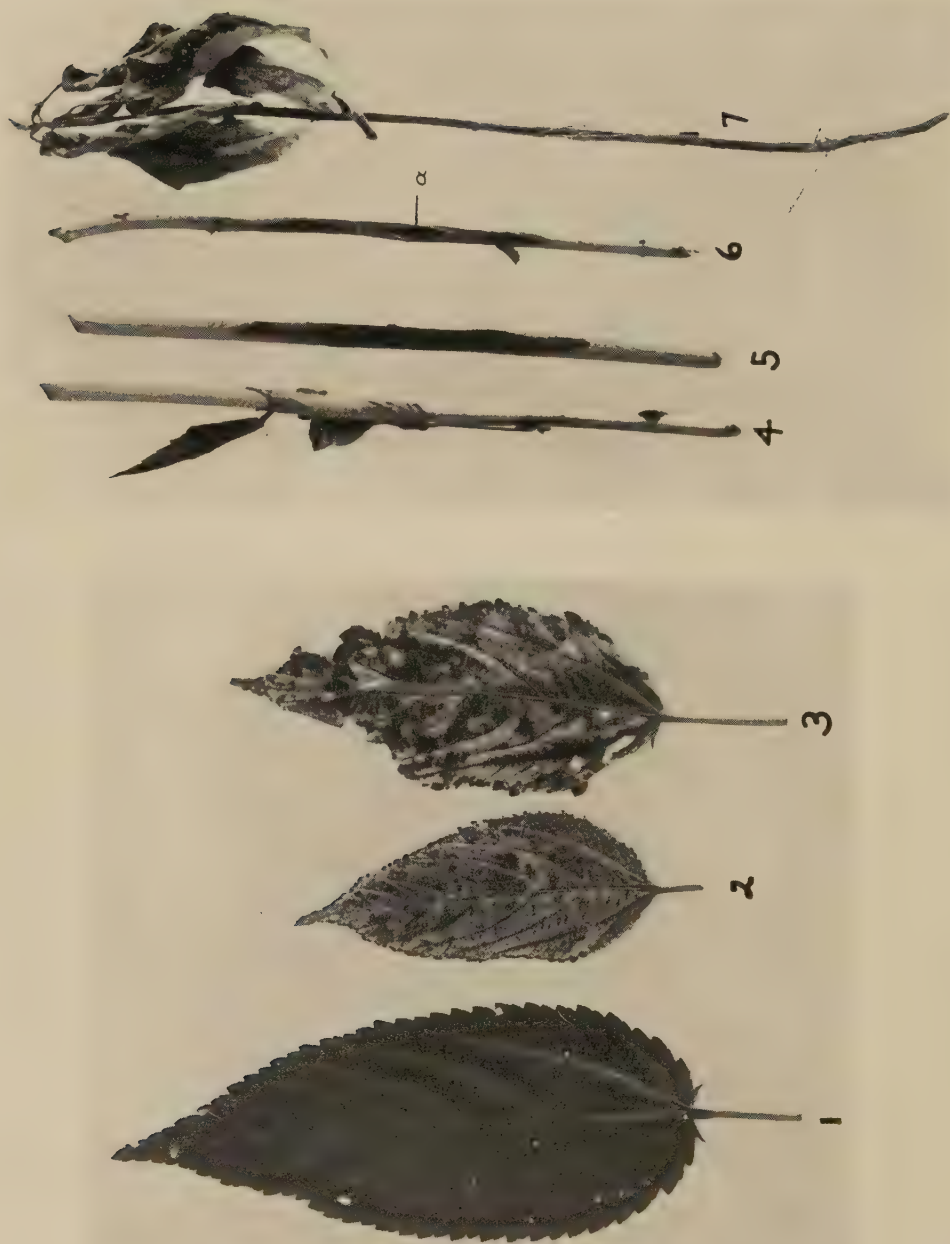
Jute is commonly subject to three diseases *viz.*, stem-rot, chlorosis, and black band of the stem. Investigations on hand aim at reducing the incidence of disease by (1) bringing about conditions which are unfavourable for the spread of disease, and (2) producing plants which escape or resist the disease.

A. *Macrophomina phaseoli*.—

What Shaw originally referred as *Rhizoctonia solani* has been proved by Ashby as *Macrophomina phaseoli* (Manbs.)

(a) *Field investigations*.—About a fortnight after sowing typical symptoms of "damping off" were noticed. The stems of seedlings collapsed as a result of rotting in the collar region, but in most cases the infection had not reached the roots. Blight of seedlings was also observed and in this case the infection had

Plate IV



EXPLANATION OF PLATE IV.

Fig. 1.—Healthy normal leaf of jute.

Fig. 2.—A leaf showing chlorosis. Note yellowing and wrinkling.

Fig. 3.—A chlorotic leaf showing yellowing, mottling and wrinkling prominently.

Fig. 4.—A *Macrophomina* infected leaf enveloping the stem of jute. Pycnidia are visible on the leaf, as minute black dots. Infection of the node through the diseased petiole may be noted.

Fig. 5.—Stem rot produced through the nodal infection, and spreading along the stem.

Fig. 6.—Shredding of the epidermis at *a*, an after effect of stem-rot.

Fig. 7.—Death of a young plant caused by stem-rot.

started from the cotyledonary leaves. In some of these scorched up plants, the infection had penetrated to the root-system.

Seedling infection occurred in patches, but the patches grew in size as the healthy seedlings came in contact with the diseased rotting material. During the first weeding and thinning operation, most of the diseased seedlings are removed, and in fields where this operation had been neglected a very severe attack of *Macrophomina* was noticeable, as was the case in some fields in Mymensingh.

When the crop was about a month old the infection of leaf was common. The source of this secondary infection may be the pycnosporos from the rotten and dead seedlings or from the seedlings which had partially recovered from infection. Wrinkled, yellow, necrotic leaves with innumerable pycnidia broke off, adhered to the stem and infected it. A brownish patch—a typical symptom of the stem rot—developed on the stem, but if the progress of the disease was checked the plant survived. The epidermis peeled off and the fibrous tissue was exposed. Later on the patch might extend and ring the plant completely, in which case the stalk dried up and broke. Where the ring was not formed the fungus finally invaded the roots and the plant dried up, dead stocks standing erect being a typical symptom of this root-rot.

In the main varietal trials, counts of stem rot were taken when the plants were about two months old; about 17 per cent. of the *capsularis* plants and about 5 per cent. of the *olitorius* had stem-rot. Rather elaborate and extensive counts were taken over nine acres. When the crop was eleven weeks old, about 20 per cent. infection in *capsularis* and about 12 per cent. infection in *olitorius* was observed. The disease is an important one and is fairly wide-spread in the jute districts.

(b) *Effect of environmental and climatic conditions.*—Warm humid weather (above 80 per cent. humidity), that set in during the second half of June, proved very congenial for the secondary infection of the disease. These conditions favoured the infection of the leaf and the stem. Many partially affected plants succumbed within forty-eight hours. Spells of dry weather checked the spread of the disease, as well as the progress of the symptoms. After the middle of August there was little spread of disease, as the weather conditions became unfavourable.

Agriculturally two important observations were made during the course of tours. Mention has already been made of the importance of thinning operations in controlling the spread of the disease. Two to three timely thinnings are considered necessary for this purpose. The infection was much less in the early sown, low-land crop than in the late sown up-land crop. The low-land crop escapes the disease either on account of unfavourable weather conditions for the spread of the disease when the plants are young and more susceptible, or it is hardy on account of higher fertility of low-lands.

(c) *Resistance of different varieties.*—In order to test the resistance of different varieties to “damping off” under favourable conditions for infection, a new technique of growing seedlings within wide-mouth tubes, was evolved. Surface sterilized seeds were planted in sterile test-tubes, and the seedlings were inoculated with *Macrophomina* culture. Even before the inoculation was carried out, in many cases, growths of fungus were observed on the seeds, and the seedling died in due course. After repeated trials it was concluded that either surface sterilization of seed was defective or that the fungus was borne within the seed. Further work on this problem is reported later.

For the purpose of this experiment it was therefore decided to inoculate only healthy seedlings after sufficient time had been allowed for dormant disease to appear. Thirty six hours after inoculation slight discolouration of the stem was noticed and the seedlings died within four to five days. The infected seedlings had abundant pycnidial and sclerotial bodies. All the inoculated seedlings invariably succumbed, indicating that none of the twenty-two *capsularis* and *olitorius* varieties tried, were immune to the disease under special conditions, which favoured the disease.

In the field it was, however, observed that *olitorius* seedlings rarely suffered from either “damping off” or “blight”.

To gauge the relative resistance of varieties to stem-rot, numbers of infected plants as well as the total number of plants were counted within a square yard. Squares located at random, roughly covered one-ninth of the area of the plot. The following percentages of attack for the varieties were found.

TABLE XI.

Varietal Resistance.

	Varieties.	Mean percent. of stem-rot.	Mean percent. of chlorosis.
MAIN VARIETAL TRIALS ...	CAPSULARIS—		
	D. 154	19.65	26.44
	Fanduk	20.60	27.18
	D. 386	20.81	30.20
		Not significant	Not significant
	OLITORIUS—		
	R. 26	9.29	0
	Chinsurah green	11.96	0
	Dacca Local	12.44	0
	Critical difference	1.51	
SECOND STAGE ... VARIETAL TRIALS	CAPSULARIS—		
	Fanduk × D. 154	10.07	43.35
	D. 154 × D. 27	10.58	15.15
	D. 89	13.45	25.51
	Barapat × D. 154	15.15	44.19
	D. 154	15.18	38.56
	Cross late	16.31	29.96
	Deodhali	16.79	40.64
	Megnal Satnal	17.65	39.27
	D.154 U. F. 2.12	18.19	47.55
	Dhaleshwar	19.38	35.72
	Barapat	20.25	51.92
	K. B. S. G. I	29.34	36.26
	Critical difference	9.11	Not significant.
	OLITORIUS—		
	R.26 × G. O.	5.05	0
	G. O.	5.97	0
	G. O. Aksir	8.98	0
	Berhampore	10.36	0
	G. O. Jap	12.48	0
		Not significant.	

There is abundant evidence to show that *olitorius* standard type Chinsurah Green is less susceptible to stem-rot than the *capsularis* type D.154. This has also been noticed in the districts.

(d) *The study of the fungus.*—

- (i) *Pathogenicity.*—The pathogenicity of the cultures isolated from the live diseased plants and from the previous season's dead, diseased roots gathered from the fields at Dacca, was tested. Both the cultures were found virulent and from the infected material allied cultures were recovered. Under controlled conditions various types of symptoms that have been already described were reproduced.

For inoculating a plant, the placing of the inoculum at the collar region or on the wounds is most successful. Experiments on the inoculation of soil were vitiated by the transmission of the disease through the seed.

- (ii) *Seed-borne infection.*—While conducting some inoculation experiments in sterilized Roux-tubes, it was found that some sterilized seeds did not germinate and produced fungal growths, some sprouted seeds developed a rot, and some of the seedlings produced lesions and rotting at the cotyledonary region. This suggested the possibility of a seed borne disease. Refinements in the technique of surface sterilization of seed, and the use of disinfectants of higher strength, did not prevent the appearance of the disease. Formalin proved a better disinfectant than the mercuric-bichloride, probably on account of its penetrating power. With slight variations, the experiment was repeated nine-times, but in no instance did all the chemically treated seeds prove free from the disease, though a general reduction in percentage of infected seed was noticed. This suggests the possibility of both external and internal transmission of the disease.

TABLE XII.

Treatment for 20 minutes in	Number of seeds treated.	Per cent. disease.	Treatment for 20 minutes in	Per cent. disease.
Formalin 1% ...	1586	2.67	Formalin 1%	6.36
Hg Cl ₂ 0.1% ...	1651	8.11	do. 2%	3.99
H ₂ SO ₄ 5 % ...	1751	4.05	Hg cl ₂ 0.4%	4.94
Hot water at 75°-80°C.	1730	nil.	do. 0.2%	5.39
			do. 0.1%	8.41
Control ...	1770	8.87	Control	12.44

NOTE.—No germination was recorded in the hot water treatment. Germination of formalin treated seeds was a little less. In other treatments germination was normal. In these experiments the seeds were plated on Potato Dextrose Agar and incubated at 32°C.

TABLE XIII.

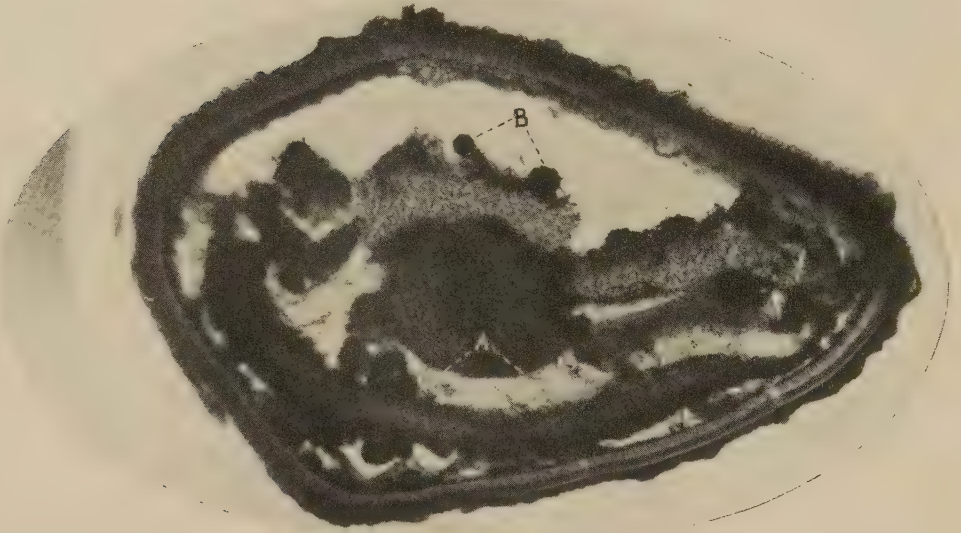
Treatments for 20 minutes in	Dry heat and D. 154 seed		Wet heat and D. 154 seed*		Wet heat and Chinsurah green seed.*	
	G. P.	D. P.	G. P.	D. P.	G. P.	D. P.
Control ...	92	16	94	15.2	97	14.1
40°-42°C ...	85	9	...	...	...	...
50°-52°C ...	90	10	95	6.9	...	...
52°-54°C ...	...	...	92	5.2	93.0	3.7
54°-56°C ...	...	...	78	4.4	78.1	1.4
56°-58°C ...	...	...	59	1.9	3	0.4
58°-60°C ...	...	...	9	0.2	1	...
60°-62°C ...	40	7	...	...	...	...
70°-72°C ...	0	10	...	...	...	...
80°-82°C ...	0	9	...	...	...	...
90°-92°C ...	0	5	...	...	...	...
99°C ...	0	0	...	...	...	...
Formalin 2%	...	...	87	6.3	7.7	4.2
Hg Cl ₂ 0.2%	...	...	90	12.3	89	13.2

NOTE.—G. P.=Germination per cent. D. P.=Disease per cent.

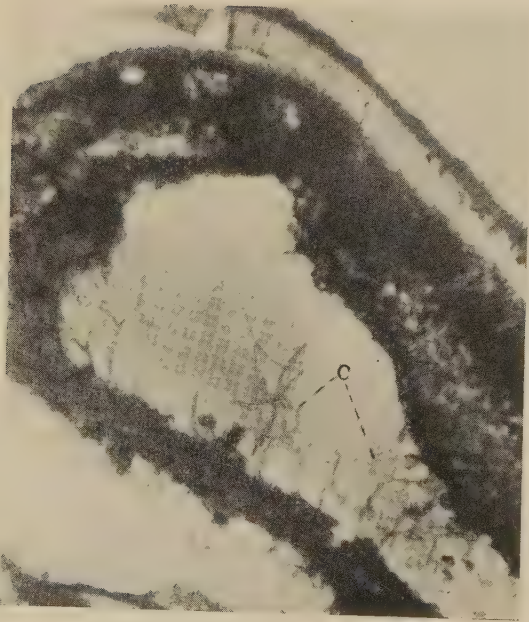
* A properly replicated experiment with a total of about 250 to 300 seeds per treatment.

Plate IV(A)

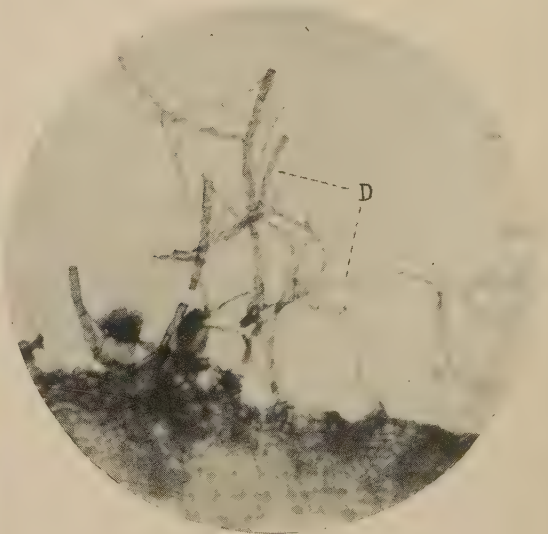
Transverse sections of *Corchorus capsularis*,
(D. 154) seed.



A. Mycelium. B. Sclerotial bodies. (X60)



C. Mycelium within the
cotyledons. (X300)



D. Hyphal growths. (X500)

Table XIII shows that hot-water treatment of seed might prove useful in reducing the infection.

When the seeds were examined under a binocular microscope, bits of peduncles of immature capsules bearing sclerotial bodies were found to be mixed with the seeds. The seeds themselves were found to vary in colour and size. Many seeds bore sclerotial bodies. Only ninety per cent. of the seeds could be classified as healthy on external microscopic examination *vide* Table XIV. Some of the suspected discoloured seeds were macerated after soaking, and when examined under a binocular microscope showed coloured bodies inside the cotyledons. Hand sections of soaked seeds of D.154 revealed the presence of mature fungal hypha and sclerotial bodies within the seed. Seeds which superficially appeared entire, had cavities below the seed coat, and the cotyledons and the endosperm had disintegrated. Where the cotyledons and the endosperm were fairly intact, the sclerotial bodies were just under the seed coat. The pathogenicity and virulence of the fungus isolated from the seeds were proved.

TABLE XIV.

External Microscopic examination of seeds.

Number of seeds examined.	Number with sclerotial bodies.	Number with hyphal growths.	Number light and shrivelled.	Number healthy.
2140	27	11	168	1934
Per cent. ...	1.25	0.52	7.9	90.33
Per cent germination in each group ...	0	16	25	93.7
Percent of Diseased seedlings ...	—	100	12.1	5.5

The relative importance of soil and seed borne infections has to be ascertained. It is, however, clear that disease free soil may be infected through the diseased seed.

(iii) *Physiological races*.—Severe out-break of root-rot of cotton was noticed on Dacca Farm and a culture from cotton was isolated. Cross-inoculation experiments with this culture revealed that the culture from cotton was not as virulent as the culture from Jute.

B. *Diplodia Corchori*.—

Late in the season, when the flowering phase had just set in, this disease appeared. On the leaves yellowish to brownish spots appeared which later spread to the petiole and the stem. In many cases the axillary and apical buds dried up and some of the infected plants dried up completely. In mature plants, the pods were found to be infected and pycnidia were present.

The disease was first noticed near Gaffargaon in Mymensingh district, and appeared in the Dacca farm in the beginning of August. The disease gradually spread to most of the plots, but as it appeared late only the seed crop was damaged. Pathogenicity of the fungus was proved by inoculation experiments. The disease was found scattered among all the varieties. A special experiment will have to be laid down to study the varietal resistance.

C. *Chlorosis*.—

Considerable variation in the symptoms was observed. On some of the plants the young shoots showed no chlorosis whereas, the old shoots were chlorotic. There were instances wherein only a single branch was chlorotic. Some of the chlorotic plants became quite normal. Sudden spread, partial chlorosis, and recovery suggest the possibility of a virus disease.

When the plants were two months old, about 48 per cent. of the plants had chlorosis; three weeks later on the same plots the percentage of chlorosis was reduced to thirty. None of the *olitorius* types recorded chlorosis; and among *capsularis* varieties, the differences were not wide enough to be significant *vide* Table XI.

D. *Effect of manures on the incidence of disease*.—

Sixteen treatments with N, P, K, and Ca and its combinations were tried, over a basal dressing of cattle manure. In general the outturn of fibre was significantly higher in the plots which received N in combination with P or K or P + K. In these treatments the plants reached a maximum height, and the percentages of stem-rot were significantly low. The percentage of chlorosis was, however, significantly higher wherever N was applied either singly or in combination. The results indicate

TABLE XV.

Effect of fertilizer application.

Treatment.	Mean per cent. Chlorosis.	Treatment.	Mean yield per acre lb.	Treatment.	Mean per cent. Stem-rot.	Treatment.	Mean height ft.	Treatment.	Mean fibre percentage.
pk	18.90	npk	1341.66	npkca	4.49	npk	6.12	nca	6.10
p ca	23.07	np	1282.35	nk ca	8.76	npk ca	6.28	n	5.82
p	23.73	nk ca	1256.07	nk	9.81	nk ca	6.20	np	5.75
k ca	30.38	npk ca	1247.39	npk	9.94	np	6.14	nk	5.65
ca	30.57	nk	1129.39	np	10.27	nk	5.93	np ca	5.62
o	31.40	np ca	1065.10	np ca	12.33	np ca	5.43	npk ca	5.49
pk ca	31.57	n ca	758.48	pk ca	14.87	n ca	4.89	nk ca	5.27
k	31.73	n	662.89	k ca	15.22	pk ca	4.87	ca	5.19
np	32.80	ca	655.17	pk	16.62	k ca	4.83	p	4.97
npk	39.75	pk ca	625.23	k	22.53	n	4.77	npk	4.93
npk	40.47	k ca	563.17	pca	28.48	p ca	4.65	pk ca	4.92
nk ca	40.55	k	542.37	p	31.48	ca	4.62	pk	4.91
n	41.00	pk	495.44	n ca	34.13	pk	4.59	k ca	4.72
npk ca	43.78	p	494.28	n	35.97	k	4.58	o	4.65
n ca	46.36	o	493.03	ca	38.98	o	4.35	k	4.58
np ca	54.11	p ca	453.55	o	40.36	p	4.33	p ca	4.43
C. D.	13.85	C. D.	58.62	C. D.	12.61	C. D.	0.55	C. D.	0.79

NOTE.—O=farm yard manure (basal dressing for all treatments) at 100 md. per acre; n=Ammonium sulphate at 6 md. per acre; p=Super phosphate at 3.48 md. per acre; k=Muriate of potash at 1.83 md. per acre; ca=Lime at 9.83 md. per acre.

that chlorosis does not affect the yield appreciably, whereas the stem-rot does. In the treatment NPKCa the percentage of stem-rot infection was the lowest 4.49 as against 40.36 per cent. in the control. Financially, the application of six maunds of ammonium sulphate in combination with three and a half maund of super-phosphate per acre, proved most profitable.

E. *Miscellaneous.*—

During the inspection of the Bihar seed jute crop root galls of jute were observed which resulted in the wilting of the plants. On these root galls a nematode was discovered. Subsequently the occurrence of nematode-root galls was also observed in the Dacca crop.

Seeds from Barogha factory were examined for the presence of nematodes, but no nematodes were found. Both the *macrophomina* and *Diplodia* species were, however, recovered from these seeds.

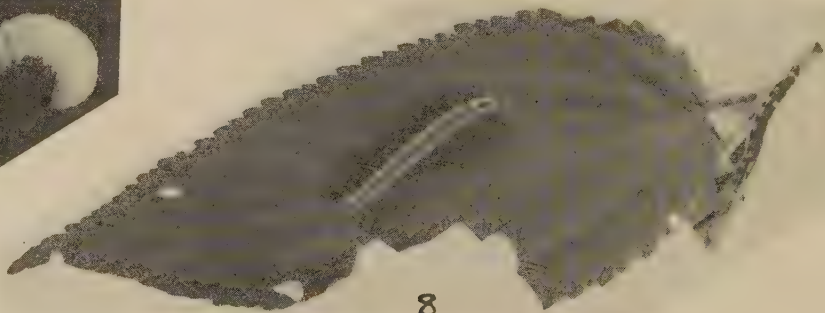
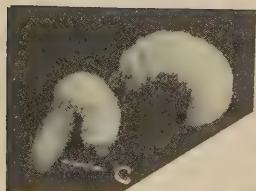
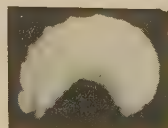
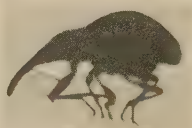
VIII. PESTS.

The loss caused to jute by insects must be heavy, but the estimate of the amount and the extent of damage have not been so far attempted. The first task was therefore to find out what the insects do to the jute crop. From the survey of jute pests, it appears that the Jute Apion is the most important pest, as it lowers the quality of the fibre and prevails over a wide area. Purely from the point of view of fibre outturn, the jute-semilooper, the hairy caterpillar, and the indigo-caterpillar are important. The investigations in progress aim at reducing the damage caused by insects. This involves (1) a study of the factors responsible for insect abundance, (2) location of the *critical period* in the life-history of the pest and (3) estimation of the resistance of different varieties to insect attack. The following is an account of the progress made in these directions.

A. *Jute Apion*—*Apion corchori* Marsh.—

(a) *Life history.*—Jute apion is a small dull-black weevil measuring 1.7 mm in length, and it often escapes notice. The weevil stands on the lower surface of the apical petiole, bores a hole in the stem with its rostrum, turns around, and lays a single egg. The mouth of the hole may be closed with the dark refuse. The egg which is placed in the cortical region hatches in three to

Plate V



EXPLANATION OF PLATE V.

Fig. 1.—Hairy caterpillars on jute.

Fig. 2.—Jute fibre showing "knots" caused by Jute Apion.

Fig. 3.—A stem showing Apion damage. At *a*, a 'knot' will appear when the fibre is retted.

Fig. 4.—A split stem of jute showing the grub (*b*) in situ.

Fig. 5.—An adult of Jute Apion—a weevil ($\times 10$).

Fig. 6.—A grub of Jute Apion ($\times 12$).

Fig. 7.—A parasite feeding on a grub of Jute Apion (*c*).

Fig. 8.—Jute Semiloopers. The one on the extreme right is feeding on a growing leaf.

four days, the grub feeds on the cortex and parenchyma. The fibre, xylem and pith are damaged. The grub occasionally bores right across the stem, but most often it wanders within the internal tissues. After it is about fifteen days old, it pupates within the stem, mostly in the pith. The weevil emerges after five days and comes out through the hole made by the mother or by the grub. Within three or four days of emergence, pairing takes place. Adults feed on the young and tender leaves of jute.

Egg laying and the emergence of weevils do not appear to be confined to any particular period during the crop season. Both these phases have been observed at Dacca throughout the growing period of the crop *i.e.*, between May to September. Grubs have been collected from stray jute plants even upto January. There is no evidence of a regular brood.

In the late season, after August, the weevils prefer to lay eggs on the collar region of mature plants, and the grubs in such plants were generally confined to the bark and the pith remained most often undamaged.

(b) *Incidence of the weevil and the extent of the damage.*—When punctures are made for laying eggs on young seedlings, the top shoot often dries up and the plant branches, thus causing a reduction in the length of the fibre. If older plants are attacked, the shoot may not wither, but around the damage caused by the grub, mucilagenous substance is accumulated, which binds the fibres together. Even after retting the knot remains. At the knot the fibre breaks during processing. Apart from that, the continuity of the fibre is cut by the grub during the course of its feeding. In the event of light attack, the fibre becomes "specky" having numerous black specks, each speck corresponding to a puncture.

As many as thirty three punctures were observed on a single plant. When the crop was six weeks old about 28 per cent. of the plants were found to be damaged in a certain field. In the same field, six weeks later, 75 per cent. of the plants proved to be damaged. Varietal resistance under field conditions was estimated, the method being the one followed for stem-rot. The results are furnished in Table XVI.

In the manurial experiments, in general, the attack was significantly lower in the plots which received N in combination with P or K, or P + K, *vide* Table XVI.

TABLE XVI
Resistance to Jute Apion 1939.

Main Varietal Trials: Field— South Miror Tek; Sown—9 to 11-5-39; Observed—17 and 18 July 1939.		IInd Stage Varietal Trial; Field—Southern Miror Tek; Sown—10th May 1939 Observed—20th July 1939.		IInd Stage Varietal trial Field—South Moster Tek, Sown—9th May 1939; Observed 21st July 1939.		Manurial Experiment; Field—South Moster Tek; Sown—18th May 1939; Observed—18th July 1939.	
Varieties.	Attacked plants per cent.	Varieties <i>Capsularis</i>	Attacked plants. per cent.	Varieties <i>Olivorus</i> .	Attacked plants per cent.	Treatment	Attacked plants per cent.
<i>Olivorus</i>							
R. 26	13.8	Deodhali	46.07	G. O. Lalpat	53.67	nkca	45.7
Chinsurah green	17.2	Meghal Satnal	46.77	Chinsura green	56.28	npk	51.9
Dacca Local	23.1	Barapat × D.154	53.14	R. 26 G. O.	57.67	np	52.0
C. D. ...	7.19	Fanduk × D.154	53.49	G. O. Jap.	59.14	npkca	52.8
<i>Capsularis</i>							
D. 154	57.35	D. 154 + D. 27	55.81	G. O. Aksir.	60.45	pca	54.1
D. 386	59.71	C Late	58.05	Berhampore Local	68.34	nk	57.3
Fanduk	65.18	K. B. Sgi.	58.29	C. D.	8.02	pk	59.3
Not significant		Barapat	58.63			npca	60.4
		D. 154	60.08			p	60.6
		D. 89	62.16			pkca	61.3
		Dhaleswari	63.62			ca	64.3
		D. 154 (U. F. 2. 12)	64.52			k	66.7
		Not significant				o	69.4
						kca	71.3
						nca	74.2
						n	74.4
						C. D.	18.2

(c) *Modes of hibernation*.—Examination of the soil around the stubbles, has not as yet revealed the presence of any grubs or pupae. In the laboratory experiments, the grubs did not migrate from the stubbles to the soil, nor did they hibernate in the stubbles, but emerged in due course as weevils. On the leaves of *Triumfetta rhomboidea*, a weed, the weevils were found to be feeding after the jute crop was removed. This weed is a possible alternative host on which the jute apion breeds. Weevils are found hiding in hedges and bushes such as *Duranta*, *Hibiscus rosa-sinensis*, *Pithecolobium* sp., *Streblus asper*, *Glycosmis pentaphylla*, *Zizyphus oenophia*, *Blumea lacera* and Guinea grass, but they do not appear to feed on the leaves of these plants. After over-wintering in shrubs the weevil comes out in February and March and attacks seedlings of jute.

(d) *Efficiency of parasites in the control of the pest*.—Two hymenopterous flies were found to parasitize the grub of jute apion. The eggs of these flies are laid singly on the body of the grub or rarely on the pupa. The larva of the parasite feeds on the tissues of the grub, thus killing it completely. From a study of about 200 grubs and pupae collected from the live-plants, it was found that 62 per cent. of the grubs and pupae were killed by the parasites.

B. *Other pests*.—

(1) *Jute Semilooper*.—*Cosmophila sabulifera* appeared in March, but heavy attacks were recorded in the months of June and July. By the time the crop flowered the pest disappeared.

Several eggs may be laid singly on the upper surface of the top-most leaves. After a few days, the green caterpillars emerge, and feed mostly on the leaves. The caterpillar becomes full-fed in about sixteen days and for pupation enters the soil or hides under dead leaves. After passing eight days as a chrysalid, the moth emerges.

There was rather a serious attack of this pest in the Faridpur experiments, and the pest was brought under control by spraying with lead arsenate. Nicotine sulphate was also found to be effective for the control of young caterpillars at Faridpur.

(2) *Hairy Caterpillar*.—*Diacrisia obliqua* can be a very serious pest unless it is checked immediately after its appearance. Once the caterpillars have swarmed the field, nothing but the bare stems will remain. The pest was noticed about three miles off from the farm on 2nd of May, appeared on the farm in June, and it was serious during June and July.

During the night, pearly green eggs are laid in clusters on the lower surface of the leaf. Egg-laying is continued for three or four consecutive nights, a single moth laying between 400 to 1,000 eggs. Eggs hatch in about six days and the young caterpillars feed on the leaves and render them membranous. After six or seven days they spread over the entire field and feed on the entire leaf tissues leaving the ribs. After fourteen to twenty days, the caterpillars enter the soil for pupation. After resting for nine days the moths emerge. Soon after emergence they pair and commence to lay eggs after two days. Four broods were noticed. Collection and destruction of young caterpillars when in clusters proved quite successful.

(3) *Indigo-caterpillars*.—*Laphygma exigua*—the eggs are laid in clusters. Caterpillars feed on the leaves, and completely defoliate the plant. Full-fed caterpillars enter the soil for pupation and after a resting period of about eight days, the moth emerges and commences the egg-laying within four days.

This is a pest on the seedlings and does not appear to attack the jute crop after it has attained a height of over a foot. The pest was observed in Rangpur district during March, and at Dacca farm in May.

(4) *Minor pests*.—Mites, Jute Buprestid, Wire-worms, White-ants, Aphis, Thrips, *Scopula emissaria*, and *Prodenia litura*, the last two which do not appear to have been recorded on jute, were met with.

IX. CROP-CUTTING EXPERIMENTS.

A half acre plot of D.154 was harvested in the manner of a uniformity trial. Two thousand three hundred and four plots of one square yard each were individually harvested. The stand, mean height of the plant, green weight, and the fibre weight of each of these plots have been recorded. The data remain to be analysed.

X. SUMMARY.

The report covers the first jute season and nine months' working of the Agricultural Research Laboratories which were completely fitted up in June 1939.

To apportion the influence of varieties, growth conditions and retting waters on the quality of the fibre two sets of quality trials have been commenced. In the first set, varieties D.154, D.386 and Fanduk, reputedly a good quality type, have been grown at Rangpur, Faridpur and Dacca farms. The second set consisting of Chinsurah green, R.26, and a local variety was grown at Chinsurah, Rajshahi and Dacca farms. From these out-stations a part of the green produce was brought to Dacca for retting. Samples of fibres obtained from these two sets have been sent to the Technological laboratories for spinning tests, the results of which are awaited. From the yield figures obtained in these two sets of trials, the factors which make up the yield have been analysed. The yield of fibre of a particular variety is determined by its height and fibre percentage, the latter appears to be a characteristic of the variety. Early maturing varieties such as Fanduk attain low height and consequently the yield is less.

A number of crosses were made with a view to combine in a single plant, desirable characters from different types of jutes. Eight hundred individual plants possessing certain useful characters were selected. A plant that is selected has to be kept for seed and it is not practicable to extract its fibre. This difficulty has been overcome by determining 115 correlations of the fibre content with the measurable characters of the plant. By measuring the diameter and the height of the stem of the jute plant, it is possible to select plants having a high fibre content.

One hundred and seventy-eight lots of seed, taken over from the Fibre Section were grown and studied in detail with reference to yield, plant height, chlorosis and branching. On growing twenty-two samples of seeds received from the jute districts in Bengal, it was found that only two samples were botanically pure. In one case there was as much as forty-four per cent. mixture. The importance of steady supply of pure seed is therefore paramount.

In an effort to study the influence of the composition of the retting water on quality, eighty-six samples of retting waters were chemically analysed for pH, calcium, potash, magnesium and iron contents, and titrable acidity, hardness and total solids. These analyses were necessarily confined to the waters in which the experimental jute was retted. Samples were examined periodically. Waters of different stations varied greatly in their constituents, the Dacca water being the softest, and the Faridpur the hardest. The Dacca water contained more of iron and the Dacca retted fibre proved generally the darker in colour. During the retting the acidity of the water increased.

A microscopic study of the formation of fibre, its structure and development, stage by stage was carried out. The first fibre layer was observed in a very young seedling having four leaves which indicates that the actual pre-fibre formation stage is a very short period in the life history of jute plant. The first fibre layer was arranged in a ring facing the cambium and below the starch sheath, adjoining the cortex. As the secondary growth proceeded more fibres were developed in the form of bundles or groups by the cambium towards the region of the bark below the first fibre layer. So jute fibres are nothing but the secondary phloem fibres. The fibre bundles are arranged in concentric layers which in turn alternate with similar layers of soft tissues. The general topography of the stem as viewed in a cross section is striking due to the concentrically arranged phloem pyramids on the woody cylinder. A number of fibres are coherently attached forming a fibre bundle which is surrounded on all sides by soft tissues. Between $1\frac{1}{2}$ to 3 months a majority of the fibre layers are formed and this period may be the most critical for jute. At harvest, a maximum of eighteen layers in D.154 and thirteen layers in Chinsurah green were observed. The number of fibre layers diminishes from the bottom to the top as the plant tapers upwards; and near the apex there may be only one layer. The fibres formed towards the outside are older and those towards the interior are younger.

Jute fibres *in situ* clothe the hard woody cylinder all around as continuous strands from bottom to the top. These fibre groups do not run straight but form a sort of mesh or net-work in relation with the rays. Near the lower portion of the plant the mesh is long and wide, and gradually decreases as the top is

approached where the mesh is not apparently visible. Similarly the fibres of the outer part of the stem have got longer and wider mesh than towards the interior. The fibres obtained from the bottom and outer part of the stem will therefore be coarse textured.

Microscopic examination of the stem showed that adventitious roots arise from the ray parenchyma cells in between the phloem pyramids. These roots have no connection with the fibres and seldom attack, displace or obliterate them.

The conditions under which the roots are produced were investigated and it was found that alternate drying and flooding favoured the production of a larger quantity of roots. The greater the depth of water, the larger was the production of roots. Certain varieties produce more roots than the others.

The possibility of growing fibre-jute in lines was examined but no conclusion could be reached. Experiments on seed jute which aimed at cheapening the cost of production of seed, showed that a spacing of fifteen inches between the rows and six inches between the plants can effectively replace the broadcasting of seed. Enhanced out-turn of seed consequent on the application of a single dose of fertilizer Niciphos—II (125 lb. per acre) proved remunerative and almost as effective as the application of double dose.

In a manurial experiment carried out on the Dacca Farm, it was found that manuring with six maunds of ammonium sulphate and 3.5 maunds of superphosphate per acre was most beneficial and economical as long as the price of jute was not below Rs. 6/- per maund. If the price ranges between Rs. 3/- and Rs. 6/- per maund only the liming of land at the rate of 10 maund per acre is worthwhile. Plants grown in plots manured with nitrogenous and potash or phosphate fertilizers resisted better the attack of jute-apion and stem-rot.

The stem-rot fungus was found to cause, in very young seedlings 'damping off' and blight, in leaves necrotic lesions, and in mature plants stem and root rots. Factors which favoured the spread of the disease were, (a) late sowings, (b) warm humid weather and (c) negligence in first thinning of plants. Resistance of twenty-four varieties was ascertained, and in general Tosha (*olitorius*) proved more resistant than the Deshi—*capsularis*. Hitherto, only the soil was known to be the source of infection of

this disease, but our work has conclusively shown that the infection is also carried deep within the seed, as well as on the surface of the seed. A method for disinfecting the seed by treating them in hot-water is being worked out.

The peculiar behaviour of chlorosis, *viz.*, sudden spread, partial infection of the plant, and the recovery of diseased plants suggested the possibility of a virus disease. Tosha varieties were completely immune to chlorosis, but none of the Deshi varieties appeared to resist the disease to an appreciable extent. Nitrogenous fertilizers increased the incidence of chlorosis. Chlorosis, unlike stem-rot did not appear to affect the yield appreciably.

From the survey of pests of jute it appears that the jute-apion, the jute-semilooper, the hairy caterpillar and the indigo-caterpillar are the important pests of jute. The last three being mainly leaf-feeders, retard the growth of the plant. The jute apion is a stem-borer and its grub feeds on the bark thus breaking the continuity of the fibre. A knot is produced by 'gumming' of the fibres. In the event of a light attack, the fibre becomes 'specky'.

With a view to control the insect at a critical stage in its life, life-histories of these pests were investigated. The jute apion was found to hibernate during winter in shrubs and bushes, and this is a possible stage for the control of this difficult pest. Resistance of varieties to jute apion was studied.

Certain control measures against the jute-semilooper and the hairy caterpillar were adopted with success. Two unrecorded pests on jute were observed.

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ENCLOSURE I.

TOTAL CORRELATION COEFFICIENTS.

PLANT CHARACTERS.	Green weight.	Stripped weight.	Fibre weight.	Plant height.	Fibre length.	Base diameter.	Middle diameter.	Top diameter.	Bark thickness.
Stripped weight	+0.983								
Fibre weight	+0.968	+0.979							
Plant height	+0.741	+0.767	+0.761						
Fibre length	+0.812	+0.833	+0.836	+0.898					
Base diameter	+0.906	+0.918	+0.914	+0.719	+0.802				
Middle diameter	+0.898	+0.906	+0.898	+0.694	+0.766	+0.869			
Top diameter	+0.758	+0.768	+0.752	+0.517	+0.701	+0.752	+0.768		
Bark thickness	+0.677	+0.695	+0.695	+0.543	+0.586	+0.696	+0.666	+0.590	
Fibre percentage	+0.188	+0.123	+0.245	+0.193	+0.229	+0.152	+0.139	+0.089	+0.163

r 0.089 significant at 5%, rest significant at 1% level.

ENCLOSURE II

Total and partial correlations.

Total	Partial						
r 12	r 12.3	r 12.4	r 12.5	r 12.34	r 12.35	r 12.45	r 12.345
+ 0.979	+ 0.950	+ 0.874	+ 0.959	+ 0.853	+ 0.930	+ 0.863	+ 0.841
r 13	r 13.2	r 13.4	r 13.5	r 13.24	r 13.25	r 13.45	r 13.245
+ 0.761	+ 0.077	+ 0.368	+ 0.636	+ 0.064	+ 0.076	+ 0.362	+ 0.067
r 14	r 14.2	r 14.3	r 14.5	r 14.23	r 14.25	r 14.35	r 14.235
+ 0.914	+ 0.188	+ 0.813	+ 0.833	+ 0.171	+ 0.173	+ 0.744	+ 0.170
r 15	r 15.2	r 15.3	r 15.4	r 15.23	r 15.24	r 15.34	r 15.234
+ 0.695	+ 0.099	+ 0.517	+ 0.202	+ 0.096	+ 0.063	+ 0.184	+ 0.061
r 23	r 23.1	r 23.4	r 23.5	r 23.14	r 23.15	r 23.45	r 23.145
+ 0.767	+ 0.167	+ 0.388	+ 0.646	+ 0.147	+ 0.165	+ 0.383	+ 0.150
r 24	r 24.1	r 24.3	r 24.5	r 24.13	r 24.15	r 24.35	r 24.135
+ 0.918	+ 0.279	+ 0.824	+ 0.841	+ 0.284	+ 0.269	+ 0.756	+ 0.261
r 25	r 25.1	r 25.3	r 25.4	r 25.13	r 25.14	r 25.34	r 25.134
+ 0.695	+ 0.099	+ 0.517	+ 0.197	+ 0.097	+ 0.043	+ 0.179	+ 0.043
r 34	r 34.1	r 34.2	r 34.5	r 34.12	r 34.15	r 34.25	r 34.125
+ 0.719	+ 0.089	+ 0.058	+ 0.565	+ 0.044	+ 0.082	+ 0.053	+ 0.041
r 35	r 35.1	r 35.2	r 35.4	r 35.12	r 35.14	f 35.24	r 35.124
+ 0.543	+ 0.030	+ 0.022	+ 0.085	+ 0.014	+ 0.012	+ 0.0095	+ 0.0055
r 45	r 45.1	r 45.2	r 45.3	r 45.12	r 45.13	r 45.23	r 45.123
+ 0.696	+ 0.208	+ 0.203	+ 0.524	+ 0.189	+ 0.208	+ 0.202	+ 0.189

Variates.—1=fibre weight ; 2=stripped weight of the green plant ; 3=plant height ; 4=diameter of the stem at the base ; 5=thickness of the bark near the base of the stem.

